Abstracts

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Biochemistry of xyloglucans in regulating cell elongation and expansion, T. HAYASHI: "The Cytoskeletal Basis of Plant Growth and Form" (C.W. Lloyd ed.), Academic Press, London, p. 131–144 (1991).

Recent research data provide that biodegradation of xyloglucan contributes to auxin-induced loosening of cellulose microfibril networks to render the wall susceptible to turgor-driven expansion. The review focuses on assessment of functional polymer xyloglucan.

Cell, gene engineering techniques and cell technology, T. HAYASHI: "Plant Cell Technology" (H. Tanaka, S. Takayama, Y. Mano, T. Hayashi, M. Inoguchi eds.), Ohmusha, p. 15–204 (1992).

Recent cell technology in higher plants was reviewed.

Surface carbohydrates of plant cell during development, growth and differentiation and Plant cell technology, T. HAYASHI: Carbohydrate Engineering (A. Kobata ed.), Sangyo Chosakai, p. 359–376 (1992).

Carbohydrate engineering in higher plants was reviewed.

Tree lectins——Sugar recognizing proteins, H. KURODA: "Utilization of Wood Extractives", The Japan Wood Research Society (Research Project Div. 3) ed., p. 69–78 (1991).

Recent advances in the lectins localized in trees are reviewed. The article refers to their structures and functions, and to their utilization as new forest products.

Biomimetic chemistry in lignin degradation, M. SHIMADA: *Mokuzai Gakkaishi,* **37,** 1103–1114 (1991) (Review, in Japanese).

Recent advances in lignin biodegradation and biomimetic lignin degradation were reviewed.

Lignin degrading enzymes, M. SHIMADA: "Chemistry and Biochemistry of Mushrooms" (Eds., T. Mizuno and M. Kawai), Gakkai Shuppan Center, Tokyo, p. 183–195 (1992) (in Japanese).

Lignin degrading enzymes were comprehensively reviewed, and discussed in relation to the secondary metabolism of veratryl alcohol and oxalic acid in wood-destroying mushrooms.

Utilization of lignin degrading enzymes and biomimetic catalysts, M. SHIMADA: "Utilization Technology of Wood Biomass" (Eds., M. Shimizu et al.), Bun-Eidoh Publisher, Tokyo, p. 141–163 (1991) (in Japanese).

Abstract

Recent advances in lignin biodegradation research with lignin degrading enzymes and biomimetic porphyrin catalysts were comprehensively reviewed.

Mechanism of lignin biodegradation by white-rot fungi, T. HATTORI, T. UMEZAWA, M. SHIMADA and T. HIGUCHI: "Lignocellulosics; science, technology, development and use" (J.R. Kennedy, G.O. Phillips and P.A. Williams eds.), ELLIS HORWOOD LIMITED, England, p. 73–82 (1992).

Mechanism of lignin biodegradation by white-rot fungi was reviewed.

Aromatic ring opening of lignin monomeric model compounds by lignin peroxidase, T. HATTORI: *Wood Research,* No. **78**, 15–73 (1992).

Recent studies on "Aromatic ring opening of lignin monomeric model compounds by lignin peroxidase" were reviewed.

1. Mechanisms for aromatic ring opening of 3,4-dimethoxybenzyl alcohol by lignin peroxidase and model catalyst.
2. Degradation of phenolic and biphenyl lignin model compounds by lignin peroxidase.
3. Role of veratryl alcohol in lignin biodegradation.

Sugar components in malt whisky I. Analysis by gas chromatography, K. SATO, F. NAKATSUBO, K. MURAKAMI and T. HATTORI: *Mokuzai Gakkaishi,* **38**, 608–611 (1992).

The taste of malt whisky is affected by the compounds extracted from the wood cask. Monosaccharides in malt whisky during maturation were analyzed quantitatively by gas chromatography, and the data obtained were compared with those on commercial Scotch, Irish, and Bourbon whiskies repored by Nykanen. *proto*-Quercitol and arabinose increase with the maturation period. The contents of glucose and mannose in malt whiskies do not change between five- and ten-year-old whiskies, but those in commercial Scotch whisky are very large due to the addition of caramel for color adjustment or to maturation in sherry-casks. Bourbon whisky contains larger amounts of monosaccharides than those in malt whisky, especially the contents of xylose and galactose are extremely large. These compounds come from the wood of new casks well-charred. Therefore,the analysis of monosaccharides in whisky makes it possible to obtain useful information about the extent maturation and as to whether caramel is added into commercial whisky and sherry- or charred-cask is used for maturation. Consequently, the present analysis may be a useful method for the evaluation of commercial whisky.

Kinetic analysis of the noncompetitive inhibition of the lignin-peroxidase-catalyzed reaction by oxalic acid, D. MA, T. HATTORI, Y. AKAMATSU, M. ADACHI and M. SHIMADA: *Bioschi. Biotech. Biochem.,* **56**, 1378–1381 (1992).

Oxalic acid was found to inhibit noncompetitively the $C\alpha$-$C\beta$ bond cleavage of veratrylglycerol catalyzed by a lignin peroxidase (LiP) isozyme of the white-rot fungus *P.*

chrysosporium. With greater amounts of oxalic acid in the LiP system, the substrate was not converted to veratraldehyde but was almost all recovered. Oxalic acid was shown to be decomposed to CO_2 during the enzymatic reaction. The results clearly indicate that oxalic acid reduced the cation radical intermediate formed in the reaction back to the substrate to block the production of veraldehyde. A novel equation has been derived to explain the mechanism for this unique non-competitve inhibition that is different from the classical noncompetitive one. The inhibition constant K_i obtained here, which is different from the classical inhibition constant K_i is defined as the ratio of the rate constant (K_p) for product formation to the rate constant (K_i) for the reduction of the cation radical to the substrate.

Cell-free extraction and assay of oxaloacetase from the brown-rot fungus *Tyromyces palustris*, Y. AKAMATSU, M. TAKAHASHI and M. SHIMADA : *Mokuzai Gakkaishi*, **38**, 495–500 (1992).

Experimental conditions for cell-free extractions and assays of oxaloacetase (EC 3.7.1.1) of the brown-rot fungus *Tyromyces palustris* (Berk. and Curt.) Murr. were examined. The following was found to be important. a) The enzyme induction treatment with Na_2CO_3 was effective in enhacing enzyme productivity. b) The enzyme activity from a stationary culture was greater than that from a shaking culture. c) In homogenizing the mycelia and extracting the assay of oxaloacetase, the direct spectrophotometric method was more economical and convenient than the commercial method using oxalate decarboxylase and formate dehydrogenase. It is noteworthy that the oxaloacetase of *T. palustris* is not produced only constitutively but also inductively with the Na_2CO_3 treatment.

Tree species of charcoal excavated from the site AW27-ku in Kyoto University Campus, N. ISOGAWA, Y. CHIBA and T. ITOH : Kyoto-daigaku kounai-iseki Chousa-kenkyu Nenpou 1988-nendo, 28–29, Fig. 10–11 (1992) (in Japanese).

Tree species of 14 charcoal excavated from Kyoto University Campus were identified microscopically. The species identified are as follows:1 *Carpinus* L., 2 *Quercus* L. subgen. Cyclobalanposis, 3 Quercus L. subgen. Lepidobalanus, sect. Prinus Loudon, 4 *Fagus crenata* Blume, 5 Lauraceae, 6 *Acer* L., *Ilex* L., 7 *Symplocos Jacq.* except two other diffuse porous tree species.

Assembly of cellulose microfibrils in giant marine algae, T. ITOH : Proceedings of the VII International Symposium in Conjunction with the Awarding of the International Prize for Biology, Toyonaka, Osaka, 35–43 (1991).

This is a kind of review articles relevant to the assembly of cellulose microfibrils in giant marine algage. The topics were reviewed with the following chapters: Introduction, Pioneering Research on the Visualization of TCs, Structure of TCs in Valonia, General Survey of TCs in Siphonocladales and Cladophorales, Structure of TCs in Other Algal

Species, Development of Cellulose Synthesizing Complexes, The Effects of Selected Inhibitors on Cellulose Microfibril Assembly and Conclusion.

Molecular architecture of poplar cell wall by quick freeze, deep etch technique, T. ITOH and T. OGAWA: Plant Cell Walls as Biopolymers with Physiological Functions, Yamada Science Foundation, Osaka, 173–178 (1992).

The new attempt to visualize directly the molecular organization of the cell walls of poplar suspension-cultured cells was tested. The materials before or after the enzymic treatment of Pectolyase Y-23 and polygalacturonase, and the chemical treatment of EDTA, 4% KOH and 24%KOH was rapidly frozen, and deep-etched.

The gradual destruction of three-dimensional construction of cell wall by the removal of hemicelluloses after the treatment with two step of potassium hydroxide indicates that three-dimensional organization of microfibril network may be maintained by hemicelluloses. It was suggested that the main component which maintain three-dimensional structure of cell wall may be xyloglucan.

Physiological aspects of lectin in the stems of woody plants, K. BABA: *Trends in Glycosci. and Glycotech.*, **4**, 168–173 (1992).

Lectins are widely distributed in extracts of stems from woody plants. They are localized in the vacuole or protein bodies of phloem parenchyma existing in the inner bark. Lectins in the bark show an annual rhythm that they decreased in spring and increased in the autumn. Therefore, it is saggested that lectins in bark have function for the storage of nutrients. During the active period of secondary growth, from May to August, lectin decreased mainly in the outermost region of inner bark where the cork tissue differentiates and dilatation occurs. This result suggests that lectin is consumed in the process of cork tissue differantiation and/or dilatation. Recently, unique lectins in their binding specificities were found in barks. One binds to *N*-acetylneuraminic acid and the other binds to mannose, although most of the bark lectins bind to either *N*-acetylglucosamine or *N*-acetylgalactosamine. It has been hypothesized that lectins specific for *N*-acetylglucosamine and *N*-acetylneuraminic acid function as a defense system. However, exact function of lectin in tree stems has not yet established.

Studies on biological treatment of mechanical pulps (III). Effect of depression of color reversion in mechanical pulps by treatment of crude enzyme from *Coriolus versicolor* and *Phanerochaete chrysosporium*, T. YAMASHITA, U. KAGE, S. TACHIBANA, M. SUMIMOTO, K. OHSHIMA and M. KUWAHARA: *Kamipa Gikyoshi*, **45**, 1383–1391 (1991) (in Japanese with English summary).

Pre-treatment of unbleached thermomechanical pulp and unbleached groundwood pulp with extracellular crude enzyme solutions from *Phanerochaete chrysosporium* and *Coriolus*

versicolor, respectively, belonging to white-rot fungi followed by alkaline hydrogen peroxide bleaching gave a remarkable effect on depression of heat-induced color reversion of thermomechanical pulp (TMP) and groundwood pulp (GP), respectively. The effect of depression of heat-induced color reversion by treatment of unbleached TMP with an extracellular crude enzyme solution from *P. chrysosporium* seems to be related to the pH value in the culture solution. The color reversion was greatly suppressed when the culture solution have lower pH value, especially under pH 4.6. This suggests that the enzyme from *P. chrysosporium* responsible for depression of the color reversion is a kind of inducible enzyme by decrease in pH value in the culture solution during incubation. And furthermore, the enzyme responsible for depression of the color reversion was found to be strongly inhibited by heat treatment or by addition of sodium cyanide.

Furthermore, pre-treatment of unbleached GP with an extracellular crude enzyme solution from *C. versicolor,* followed by hydrogen peroxide bleaching was found to be very effective to the depression of light-induced color reversion of GP. However, no effect of depression of light-induced color reversion was observed by the treatments of both, GP and TMP with the extracellular crude enzyme solution from *P. chrysosporium.* This suggests that TMP and GP have some different chromophores contributing to the light-induced color reversion. Based on the results of the reactivity between a model compound and extracellular crude enzymes from *C. versicolor,* the enzyme responsible for depression of light-induced color revesion of TMP is a kind of oxido-reductase because reduction products as well as oxidation products are recognized in the reaction products.

Utilization of wood resources—From the standpoint of lignin biodegradation, M. KUWAHARA: *Bioscience and Industry,* **50**, 841–847 (1992) (in Japanese).

Degradation of lignin is important both in the utilization of wood biomass and environmental preservation. Progress of the studies on the utilization of lignin-degrading fungi and enzymes has been obstructed by several technical problems; large scale production of the enzymes, *in vitro* degradation of lignin macromolecule and so on. Genetic engineering, including construction of vector system applicable to the transformation of basidiomycetes, is indispensable to improve the productivity of these enzymes.

Developement of steam explosion method for biomass conversion, M. KUWAHARA and T. SAWADA: *Mokuzai Kogyo,* **47**, 157–163 (1992) (in Japanese).

Steam explosion is an useful procedure as the pretreatment of wood biomass for the enzymaic hydrolysis of the substrate and subseqent production of alcohol by fermentation. However, this procedure needs the high energy input. The two-stage explosion system has been developed to improve the energy consumption in the process.

Characterization of genes encoding lignin-degrading enzymes from basidiomycetes, M. KUWAHARA : Abstracts of International Bio Symposium 92, Nagoya, 199–204 (1992).

Analyses of genetic systems of synthesis of lignin-degrading enzymes have been accelerated in these several years. The gene encoding lignin peroxidase was cloned from cDNAs and then chromosomal DNA of *Phanerochaete chrysosporium*. At least three different cDNAs which encode distinct isozymes have been isolated and hybridization analysis indicated the presence of gene families consists of six or more distinct genes. Sequence analyses showed these genes are very similar each other in amino acid composition of the gene products and other fundamental constitutions of the genes. Lignin peroxidase gene was also cloned from *Bjerkandera adusta* and sequenced.

Characterization of a cDNA and gene encoding a lignin peroxdidase from the lignin-degrading basidiomycete, *Bjerkandera adusta,* Y. ASADA, Y. KIMURA, T. OKA and M. KUWAHARA : Abstract of 5th Intenational Conference on Biotechnology in the Pulp and Paper Industry, 142 (1992).

A lignin-degrading basidiomycete, *Bjerkandera adusta,* produces multiple extracellular peroxidase isozymes, named lignin peroxidases (LPOs), which are considered to be responsible for depolymerization of lignin. The purpose of this investigation was to clone and characterize a cDNA and gene encoding a major LPO isozyme of *B. adusta.*

A cDNA clone, λLPO-1, encoding a major LPO isozyme from *B. adusta* has been isolated and characterized. The nucleotide sequence of λLPO-1 indicated that a mature protein consists of 349 amino acid residues with a molecular weight of 37, 225, which is preceded by a signal peptide of 23 amino acid residues. Only one potential *N*-glycosylation site (Asn 103) can be identified.

Also, we have cloned the LPO gene and determined its nucleotide sequence. The nucleotide sequence of the gene revealed that protein-encoding sequence is interrupted by four introns which conform to the universal GT/AG splicing rule observed for the 3′ and 5′ intron boundaries. The putative eukaryotic regulatory sequences, i.e. "CAAT" and "TATA" box-like sequences, are present in the 5′ flanking region. Expression of the cloned LPO cDNA (λLPO-1) in yeast is currently under investigation.

Structure of neutral glucan in reishi liqueur, K. INABA, T. WATANABE, M. TAKANO, T. MITSUNAGA and T. KOSHIJIMA : *J. Jpn. Soc. Nutr. Food Sci.,* **45**, 163–167 (1992) (in Japanese with English summary).

Reishi liqueur was produced from *Ganoderma lucidum* (Leyss. : F_R.) Karst. by two-step extraction with a Japanese "sake" at 18°C for 10 days and than at 70°C for 60 min. To analyse structure of the extracted polysaccharides, the extract was dialyzed, the impermeable portion was concentrated under reduced pressure and then precipitated with

7.5 times its volume of ethanol. The precipitate was then fractionated into neutral (Ganoderan-N) and acidic polysaccharide (Ganoderan-A) by DEAE-Sephadex A-25 column chromatography. Methylation and ^{13}C-NMR analysis indicated that Ganoderan-N consists of β-(1,3)-linked glucan bearing a monoglucosyl residue at the C-6 position in every three units of glucose.

Synthesis of dehydrogenation polymer-polyose complexes by peroxidase, J. OHNISHI, T. WATANABE and T. KOSHIJIMA: *Phytochemistry,* **31**, 1185–1190 (1990).

Coniferyl alcohol was dehydrogenatively polymerized in the presence of poloses by the action of peroxidase. Binding site analysis of the resulting synthetic dehydrogenation polymer-carbohydrate complexes by 2,3-dichloro-5,6-dicyano-1,4-benzoquinone oxidation indicated that acetylglucomannan is bound *via* ether likages to the synthetic lignin predominantly at C-6 of hexose moieties while glucuronoxylan is linked at C-2 and C-3 positions of the xylan chain in a similar manner.

Conformational analysis of regio-selectively substituted cellulose esters, T. IWATA, J. AZUMA, K. OKAMURA and F. TANAKA: *Sen-I Gakkaishi,* **47**, 379–383 (1991).

The conformation of two regio-selectively substituted cellulose esters, cellulose propionate diacetate (CPDA, 2,3-di-*O*-acetyl-6-*O*-propionyl cellulose) and cellulose acetate dipropionate (CADP, 6-*O*-acety-2,3-di-*O*-propionyl cellulose), has been investigated through X-ray and electron diffraction methods. CPDA crystallizes forming an orthorhombic unit cell with dimensions $a=1.358$ nm, $b=2.221$ nm and c (fiber axis) $=1.044$ nm. The unit cell of CPDA has three sets of twofold screw axes parallel to the three orthogonal crystallographic axes, and the space group of CPDA is most likely $P2_12_12_1$. On the other hand, CADP crystallizes as a monoclinic unit cell with dimensions $a=1.108$ mn, $b=1.536$ nm, c (fiber axis) $=1.500$ nm and $\gamma=90°$. CADP has a therrfold screw symmetry along the molecular axis as does cellulose tripronate (CTP). The space group is $P2_1$ with b as the unique axis.

Molecular design of highly functionated polysaccharides IV. Molecular dynamics of cellotetraose in AMBER force field, F. TANAKA, M. KUWAHARA, K. OKAMURA and A. SARKO: *Mokuzai Gakkaishi,* **37**, 821–828 (1991).

The relationships between molecular structures and functions of polysaccharides were investigated as the first step in the molecular design of polysaccharides. Fluctuation of the cellotetraose chain structure, which exhibits the molecular properties and reactivites, was examined theoretically using the Molecular Dynamics Simulation Technique. The potential equation in the AMBER force field was applied to the molecular system of cellotetraose in this simulation. Basic factors influencing chain structures of cellotetraose molecules were classified intio three groups as a whole. The Van der Waals potential

energies were found to be principal for the molecular chain conformations. Hydrogen bondings were also important for them. Both hydrogen bondings and electrostatic interactions were foud to regulate the expansion of fluctuations in molecular motions.

Pretreatment method in the enzymatic saccharification of lignocellulosic materials—Trial for the enhancement of the enzymatic susceptiiblities of various softwood species, E. MAEKAWA: *Mokuzai Gakkaishi,* **38**(5), 522–527 (1992).

As a pretreatment for the enzymatic saccharification of lignocellulosic materials, the conjugated effect of the steam explosion process and the newly added hydrogen peroxide-alkali treatment was investigted. The following lignocellulosic were used: ine, rice (*Oryza sativa* L.), three species of hardwoods: namely, buna, Japanese beech (Fagus crenata Bl.), doronoki, Japanese poplar (*Populus Maximowiczii* Henry), itaya-kaede, Japanese painted maple (Acer mono Maxim.), three species of softwoods: namely, karamatsu, Japanese larch (*Larix leptolepis* Gord.), loblolly pine (*Pinus taeda* L.), hinoki, Japanese cypress [*Chamaecyparis obtusa* (*S. et Z.*) Endl.]. Each sample of chips used was subjected to a steam explosion uner fixed conditions. The pressure was 28 kgf/cm^2, and the treatment temperature 232°C was kept for 4 min in a closed vessed after the injection of steam. Then, the contents were released explosively into the atmosphere. After the steam explosion, various lignocellulosic samples, before and after the hydrogen peroxiode-alkali treatment, were subjected to enzymatic hydrolysis with a mixed enzyme solution of commercial Meicelase and Cellulosin AC 40 (1 : 1, w/v). By comparison of the saccharification ratios (%), the following findings were obtained: 1) Marked differences based on lignocellulosic species characteristic of biomaterials were observed. 2) Lignocellulosic samples such as rice straw, poplar, and maple chips gave enzymatic saccharification ratios (%) close to 100% by using the sample obtained after extractions with various solvents without hydrogen peroxide-alkali treatments. 3) Chip samples, such as Japanese larch, loblolly pine, and Japanese cypress, gave the very low enzymatic saccharification ratios (%) of 20–40% after the steam explosioms and extractions with various solvents. 4) In comparison with enzymatic saccharification ratios (%) of original steam-explosion samples, hydrogen peroxide-alkali treatments resulted in greater effect based on the treatment of 2–2.5 times. 5) Hydrogen peroxide-alkali treatments afforded remarkable effects based on the treatments of the softwoods, Japanese larch and loblolly pine.

Rheological properties of chemically modified wood—Relationship between dimentional and creep stability, M. NORIMOTO, J. GRIL and R. M. ROWELL: *Wood and Fiber Science,* **24**, 25–35 (1992).

A typology of chemical modifications of wood based on the interaction of water with the molecular constituents of the lignocellulosic material is proposed. The model accounts for both the moisture expansion and the so-called mechanosorptive creep induced by moisture

changes under load. Anticreep efficiency (ACE) values were obtained for wood specimens modified with fourteen different types of chemical treatments and subjected to a 4-day creep-recovery test under cyclic humidity conditions. The relationship between dimensional stability, as measured by anti-swelling efficiency (ASE), and ACE was determined for the different treatments. Treatments such as polyethylene glycol impregnation or etherification with epoxides, in which the hydrophilic nature of the bulking agent is not counterbalanced by crosslinking, yielded high ASE values but increased mechanosorptive creep instead of reducing it.

Dimensional stabilization of medium-density fiberboard by formaldehyde treatment, K. MINATO, N. KUBO, M. NORIMOTO, H. SASAKI, M. SAWADA and T. YAMAMOTO: *Mokuzai Gakkaishi*, **38**, 67–72 (1992).

Vaporous formaldehyde treatment (formalization) was applied for the improvement of dimensional instability of medium-density fiberboard (MDF). The MDF was treated with cyclic oxymethylenes as well as conventional reagent sources such as paraformaldehyde. The catalyses of sulfur dioxide (SO_2) and hydrogen chloride (HCI) were compared from the standpoint of the dimensional stabilizing effects, reastion rates, and mechanical properties. Among the SO_2-catalyzed formalizations with various reagents, tetraoxane gave the greatest antiswelling efficiency, more than 69%, which is sufficiently durable for the practical uses of MDF. The catalysis of HCI accelerated the reaction and shortened the reaction time up to within several tens of minutes. The modulus of rupture (*MOR*) in a dry state decreased 30 to 50% with increasing antiswelling efficiency, whereas the *MOR* in a water swollen state and the modulus of elasticity (*MOE*) increased extremely. The decrease of *MOR* seemed to be somewhat smaller in the HCI-catalyzed reaction than in the SO_2-catalyzed one. Other catalyzers or the pre-impregnation of formaldehyde neither did increase significantly the dimensional stabilizing effects nor shorten the reaction times. It was suggested that the dimensional stabilization of MDF is attributable mainly to the interfiber bondings.

Permanent fixation of compressive deformation in wood by heat treatment, M. INOUE and M. NORIMOTO: *Wood Research and Technical Notes*, No. **27**, 31–40 (1991) (in Japanese).

The permanent fixation of compressive deformation of sugi (*Cryptomeria japonica* D. Don) specimens by teat treatment was investigated.

The changes of the dimensional stabilities to moisture, mechanical properties, and color changes due to the heat treatment were also examined. The recovery of deformation of the heat-treated compressed specimens after boiling in water decreased with increasing of heating time and temperature. The perfect fixation of the deformation was achieved at a heating temperature of 180°C, 200°C, and 220°C for 20.5, and 3 hours, respectively.

Anti-swelling efficiency (*ASE*) of the heat-treated specimens increased with heating

temperature and time. A linear relationship between the recovery of deformation and ASE was observed. When ASE reached 40%, the perfect fixation was obtained. From these facts, it was considered that high dimensional stability of the cell walls given by heat treatment contributed the fixation of compressive deformation. The decreases of modulus of elasticity were 8.91% and 0.72% by 20 and 5 hours heating at 180°C and 200°C, respectively, while those of modulus of rupture at the same conditions were 38.5% and 34.1%, respectively. As for color changes, the decrease of the L-value was 28% and ΔE was 29 when the perfect fixation was attained.

Dielectrix relaxation of free water in wood during phase transition, Z. GUANGJIE, M. NORIMOTO and Z. YAONIAN : *J. Northeast Forestry Univ. Chaina,* **19**(5), 95–100 (1991) (in Chainese).

The changes of the dielectric propcrties of free water in wood during phasc transition were investigated. In the light of the results, the existing state of the water in wood, the analogy of dielectric relaxation between the free water under freezing and absorbed water and the analogy of dielectric relaxation between absorbed water and ice were discussed in this paper. By considering the relationship of the dielcctric characteristic parameter reseet to temperature, the method to determine the moisture content in fiber saturation point was proposed.

The Wagner's dielectric relaxation of wood-adsorptive water system, Z. GUABGJIE, M. NORIMOTO and S. DEKU : *J. Northeast Forestry Univ. Chaina,* **20**(1), 43–47 (1992) (in Chainese).

By applying wagner's theory, the relationshis between the complex dielectric constant (ε^*), the frquency (f)and the moisture content (ψ) of wood-absorptive water system was given in the paper. According to Wagner's theory, it is assumed that the distribution function of relaxation time is governed by Gauss probability function. The relationship of the parameter n of relaxation time in the distribution with respect to moisture content ψ and temperature T formulated respectively in this study. The calculated values of the dielectric constant ε' and the loss factor ε'' were compared with those measured. The results showed that Wagner's theory was more accurate than Fröhlich's. Within the near domain of the average relaxation time τ_0, Wagner's theory was consist with Fröhlich's theory. In regard to the change of the distribution of dielectric relaxation time with moisture content ψ, the parameters β in Cole-Cole's theory, ν_0/KT in Fröhlich's theory and n in Wagner's theory were also the same.

The Fröhlich's dielectric relaxation of the wood-absorptive water, Z. GUAGJIE, M. NORIMOTO and S. DEKU : *J. Northeast Forestry Univ. Chaina,* **20**(4), 49–54 (1992) (in Chainese).

The wood-absorptive water is a multi dieleetric relaxation time in such system deponds

mainly on the variation of the energy of the hydrogen bonds between water molecules and wood. The relaxation time τ_0 with respect to the moisture content were obtained in the system. The complex dielectric constant ε^* was calculated with respect to the factor frequency. The calculated values and the measured values were compared. The conclusions are as the followings.

(1) The value of ν_0/kT decreased as the moisture content increased.

(2) The calculated peak value of loss factor ε_m'' was consist with that of measured.

(3) The calculated value of diclectric constant ε' was consist with that of measured.

However, there were small deviations between the calculated values and the measured values in the range of high frequencies.

Physical properties of wood, M. NORIMOTO: "Elemental Wood Science" (Mokuzai no Kisokagaku), Kaiseisha, p. 37–64 (1992) (in Japanese).

Physical properties of wood were outlined.

Fire-resistant carbon-board materials. I. Fire endurance and physical properties of particleboards overlaid with graphite-phenolic spheres, I. IDE, S. ISHIHARA, S. KAWAI, Y. YOSHIDA, M. NAKAJI and A. TAKAMATSU. *Mokuzai Gakkaishi,* **37,** 1026–1033 (1991) (in Japanese with English summary).

Graphite phenol formaldehyde spheres (GPS) were produced by reacting phenol and formaldehyde spheres on graphite powder. The resulting thermosetting resin in powder form was used as overlays for particleboard cores in the production of fire-resistant boards. The effects of the GPS (surface) layer to board weight-ratio, the physical and mechanical properties, and the thermal insulation and fire integrity of the GPS-overlaid particleboards were evaluated.

The results were as follows:

The modulus of elasticity (*MOE*) of GPS-overlaid particleboards increased with increases in the GPS layer to board weight-ratios because of the great rigidity of the GPS layer. However, the modulus of rupture (*MOR*) decreased with increases in the GPS layer to board weight-ratio because of the brittleness of the GPS layer.

The fire integrity and endurance under fire of GPS-overlaid particleboards were improved greatly compared to particleboards without overlays and they were affected greatly by the thickness of exceed the critical temperature of 260°C. A board thickness of 44 mm is recommended for GPS overlaid particleboards for fier endurance of one hour.

Charcoal as an advanced material, S. ISHIHARA: "Sumiyaki-kakumei", Makinoshuppan Co., Ltd., p. 140–148 (1991) (in Japanese).

A review is given on charcoal as an electromagnetic shield and fire resistive material and other advanced materials.

Abstract

Elecromagnetic shield material, S. ISHIHARA: Sumi to Mokusakueki, Ienohikari Kyokai, p. 165–166 (1992) (in Japanese).

Electromagnetic shield materials made from wood charcoal and other carbon substances were reviewed.

Fire endurance of wood and wood composites with gradient phosphorylation of phosphoric acid. I, S. ISHIHARA, H. GETTO and A. SUMIDA: Proc. 4th Symp. on Gradient Functionally Materials, p. 169–171 (1991).

Gradient phosphorylation of wood with a mixture of phoshoric acid and amide by hot-pressing was done. The gradient phoshorylation of wood surface is very effective process as a fire retardant treatment. Phosphorous content of the wood decreased gradually from the surface to the core.

Forest fire research and protection from fire, S. ISHIHARA: Division of Wood Material Science, Wood Research Institute, Proc. s1.09 and s5.03–04 sessions, XIX IUFRO World Congress, Montreal, Canada, August, '90, p. 204 (1992).

This volume is a collection of papers presented at the meetings on forest fire research and protection from fire held during the XIX IUFRO World Congress in Monteal in August 1990. The contributions have been collected in two sessions: i.e. s1.09/Forest fire research and s5.03–04/Protection from fire.

Carbon composites from wood charcoal as an electromagnetic shield and fire resistive material, S. ISHIARA: Proc. All-Division 5 Conference, Nancy, France 1992, p. 125–127 (1992).

Various kinds of wood charcoal were used in the manufacture of fire resistive and electromagnetic shield composites. Relationships between carbonizing temperature and the fire resistive property and electromagnetic shielding property of the carbon composites were discussed. Fire resistivity of the carbon composites were tested by an oxygen index method in accordance with the Japan Industrial Standards (JIS) K 7201, by a burn-through method, and by cutting with an oxy-acetylene torch. Electromagnetic shielding property of the composites was tested by a DUAL chamber method in accordance with ASTM ES 7–83. Fire resistive and electromagnetic shielding effect of composites from wood and wood components were improved by the increase of carbonizing temperature.

Fire protected wood products through science, M. KOSIK, I.G. ROMANENKOV, A. KREITUSS, S. ISHIHARA, T.N. SYACHRI and S.S. ACHMADI, Proc. All-Division 5 Conference, Nancy France 92, p. 407–421 (1992).

The joint paper is devoted to the short description of the present state in fire protection in selected different areas of the world. Authors would like to show the main problems which are the matter of some research topics and the problems concerned with the

application of fire retardants for wood products, mainly materials for the construction and fire protection of buildings. The review is not exhausting and it depends on the selection of each author. Further more, we believe that the paper can show the problems which are the most frequently discussed in each of the selected countries.

Fire endurance of wood and wood composites with gradient phosphorylation of phosphoric acid. II, S. ISHIHARA, H. GETTO and A. SUMIDA: Proc. All-Divosion 5 Conference, Nancy, France 1992, p. 423 (1992).

It's well known that materials made of wood are treated with phosphorus and nitrogen compounds to improve fire resistance of them and they make carbonized layer acceleratively on cellulose materials and gives them superior fire endurance. In order to produce fire retardant wood, in general, the following method is employed which treated wood is set in a hot oven to dry or cure fire retardant agent after impregnation with vacuum and/or pressure treatment (heat-dry treatment). In this case, however, it needs a lot of fire retardant agent, energy and particular equipments, and it's not easy to impregnate or pour them enoughly into.

Then gradient phosphorylation of wood with a mixture of phosphoric acid and amide by hot-pressing was done (heat-press treatment). And the fire endurance was compared between them.

The gradient phosphorylation of wood surface is very effective process as a fire retardant treatment. Phosphorus content of tne wood decreased gradually from the surface to the core.

To carry out the reaction at the temperature required for phosphorylation or esterifcation a medium such as a water is necessary. The requirement for this are that it should be a solvent for the acid component and a swelling agent for wood. That is, it should distend the wood surface and transport the phosphorylation or esterifcation agent into cell wall of wood surface. The medium should be fluid in the anhydrous state at temperatures above 130°C and as far as possible should be chemically inert towards wood.

Here as compared with two treatment methods, they show different characteristic. Heat-press treatment even at low percent of add-on gives better results on fire resistance and even dimensional stability with short time than heat dry treatment. Heat-press treatment is more useful method to fire retardance and dimensional stability.

In this system it was considered that gradient phosphorylation or esterification and polymerization of phosphorus and nitrogen compounds carried out on wood surface in existence of water.

To illustrate, 20 mm thick of heat-press treated Basswood (Euphorbiaceae, Endsperumum) showed 1.5–2 times more in fire endurance by JIS A 1304 test method. Dimensional stability also improved 1.5–2 times more than heat-dry treated one, which was

soaked in dicyandiamide [D]-formaldehyde [F]-phosphoric acid [P] mixed solution (D/F/P=1/1/0.5) at room temperature and atmospheric pressure. Air-drying and hot pressing followed at the condition of 160°C-5 kg/cm^2. The phosphorus content of the specimens was measured and was found to be more at the surface gradually decreases as it approaches the core portion.

A barrier at the surface was formed by a high chemical reaction with some destruction of wood which would protect the materials from fire and a prevent combustion. In the core portion the retardant agent is transported in wood and produces chemical reaction.

It can be surmised that better fire endurance of wood could be attaned by the heat-press method.

Amino-phoshonate fire-retardant composites and laminates, N. KOBAYASHI and S. ISHIHARA : Proc. All-Division 5 Conference, Nancy, France 1992, p. 426, 428 (1992).

At the 1986 IUFRO S5 Congress, the present authors reported that the best of a veriety of amino-phosphonate water resistsant fire-retardants was an aqueous solution of 3-(dimethylphosphono) propionamide (DMPPA) and methylated hexamethylol melamine. At the 1988 conference the same authors showed the effectiveness of the same formulation to improve the fire-endurance of particleboard and plywood. The successful application of the formulation as a surface coating on both wooden shingles and boards was demonstrated by official fire tests (LAFD Standard No. 52 and UL 723, respectively) ; these results were reported at the IUFRO 1990 Congress by the same authors and Malkemus.

The same solution was used to saturate a glass fiber chopped strand mat (GFCSM) ; this glass reinforcement will absorb a much larger amount of the solution than glass fabric or glass paper owing to the physical absorbency of GFCSM. The impregnated and cured mat was used as a laminate in combination with various types of wood-based substrate. This laminate considerably increases the fire-resistance (FR) of wood-based substrate, particlarly when the laminate is bonded with an amino-phenolic resin with DMPPA and/or methylolated DMPPA.

Such laminates were employed in several ways. For example, as an interim layer between a particleboard substrate and a light weight decorative plywood surface which is bonded with a conventional or fire-retardant glue.

It was found that the addition of small amounts of various carbides in powder form gave large improvements; in the expansion level of the intumescence and in the resistance to the weight reduction of the laminated side of the composite when heated at high temperature. The addition of encapsulated polyammonium phosphate with/without the carbides was also beneficial.

The effectiveness of such FR composites was demonstrated. A full size particboard-based door 4 cm thik which had such a FR GFCSM bonded with the above said adhesive

easily passed a one hour fire test by the JIS A-1304 (similar to ASTM E-119, DIN-4102 etc.). Wheresas, the same door without the laminate would fail within thirty minutes in the same fire test.

Fire-resistant carbon-board materials. II. Fire endurance, electromagnetic shielding, and sound insulation performances of particleboards overlaid with graphite-phenolic sphere, I. IDE, S. ISHIHARA, S. KAWAI, Y. YOSHIDA, M. NAKAJI and A. TAKAMATSU : *Mokuzai Gakkaishi,* **38**, 777–785 (1992) (in Japanese with English summary).

Graphite phenol-formaldehyde spheres (GPS) were produced by phenol-formaldehyde condensate on graphite powder. The resulting thermosetting resin, in powder form, was used as an overlay for both surfaces of particleboard cores in the production of actual size fire-resistant boards.

The effects of the weght ratio of the GPS (surface) layer to the board, on fire integrity, fire endurance, electromagnetic shielding, and sound insulation performance of the GPS-overlaid particleboards were evaluated.

The results were as follows:

The fire integrity and endurance of 40 mm thick GPS-overlaid particleboards under fire tested according to the JIS (Japanese Industrial Standard) A 1304 fire test were more than 80 minutes with 10, 20, and 30% weight ratios of GPS overlays.

Board exposed to fire did not show any burn-through even after the unexposed surface exceed the critical temperature of 260°C.

The sound pressure level of a double wall of GPS-overlaid particleboard had a sound insulation classification of D-50 noted in JIS A1419.

The shielding efficiency of 30 mm thick and 0.60 g/cm^3 dense overlaid board with 10% GPS was over 40 dB against electric fields.

Acoustic emission monitoring during bending test of decayed wood, Y. IMAMURA, Y. FUJII, M. NOGUCHI, K. FUJISAWA and K. YUKIMUNE : *Mokuzai Gakkaishi,* **37**, 1086–1090 (1991).

The acoustic emissions (AEs) under bending stresses were monitored with two softwood specimens and one hardwood specimen in the relatively early stages of decay by brown-, white- and soft-rot fungi. The AEs of the decayed specimens occurred immediately after the beginning of loading, typically when bending stress was applied to the brown-rotted wood. With non-decayed specimens of the three wood species, AEs were generated just before fracture loads were reached. The numbers of AEs were much larger for brown- and soft-rotted woods than for white-rotted and non-decayed woods. AEs were characterized by corresponding to the types of decay fungi and wood species.

AE Monitoring to detect termite attack on wood of commercial dimension and posts, M. NOGUCHI, Y. FUJII, M. OWADA, Y. IMAMURA, M. TOKORO and R. TOOYA : *Forest Prod. J.*, **41**(9), 32–36 (1991).

An acoustic emission (AE) monitoring method for detecting termite activity in wood was applied to lumber of 3 by 3 cm to 10 by 10 cm square,1 m long. Furthermore, the propagation of AEs due to feeding activity of termites in the specimens and the locations of AE sources were analyzed. Also discussed was the feasibility of the method applied to posts out in the field of subterranean termites. The results obtained from laboratory and field tests suggest that AE monitoring could be an effective nondestructive method to detect the feeding activity of termites even in the incipient stages of the termite attack on wood.

Feasibility of AE (acoustic emission) monitoring for the detection of activities of wood detroying insects, Y. FUJII, Y. IMAMURA, E. SHIBATA and M. NOGUCHI : The Int. Res. Group on Wood Preserve, Document No. IRG/WP/2416 (1992).

The feasibility of acoustic emission (AE) as a nondestructive testing method for the detection of the wood destroying insects was investigated. AEs were detected from the wood specimens under feeding attack of sugi bark borers or powder-post beetles. However, the feasible monitoring area of an AE sensor is influenced by the attenuation of AE amplitude, so that this could be a problem in the practical AE measurements, especially with wood specimens of higher moisture content.

Improvement of physical and biological properties of particleboards by impregnation with phenolic resin, H. KAJITA and Y. IMAMURA : *Wood Sci. Technol.*, **26**, 63–70 (1991).

Particleboards were treated with a low molecular-weight phenol-formaldehyde resin and their properties were evaluated. Particles were dipped into aqueous solutions of resin or sprayed with resin solutions before spraying the conventional phenol-formaldehyde resin adhesive, or sprayed with a mixture of low molecular-weight resin and adhesive resin in a single step. Though mechanical properties and dimensional stability of the phenolic-resin-treated boards were affected considerably by the incorporated resin loading (IRL), the methods of treatment did not produce significantly different results. After boiling for 2 hours, the boards treated 10% IRL retained 80% of their strength values in the dry condition. The internal bond strength increased with increasing IRL values, and the boards with 20% IRL showed twice the value of untreated controls at the same level of board density. Treated particleboards showed a dramatic reduction in the rate of swelling even at low resin loading. Results obtained from accelerated laboratory tests of biodegradation suggested that incorporated resin-solids worked well to enhance decay and termite resistance of particleboards. For a brown-rot fungus, the weight loss was substantially reduced at 15% IRL, whereas attack was suppressed almost entirely even at

low resin loadings for the white-rot fungus.

Acoustic emission monitoring during partial compression to detect early stages of decay, M. NOGUCHI, R.ISHII, Y. FUJII and Y. IMAMURA: *Wood Sci. Technol.*, **26**, 279–287 (1992).

The acousitic emissions (AEs) under partially compression were monitored with two softwood and one hardwood specimens in very early stages of decay by a brown- and a white-rot fungus. Even slightly decayed specimens emitted AEs immediately after beginning of loading, typically when partial compression stress was applied to brown-rotted wood with the flat-headed attachment. With sound specimens of three wood species, only a few AEs were generated until the load reached at the proportional limit. These results suggest that AE monitoring will be one of the feasible means to detect the incipient stages of decay in a field test.

Liquid penetration of precompressed wood. I. Effects of compressive deformation and recovery upon liquid uptake, I. IIDA, C. TAKAYAMA, O. MIYAGAWA and Y. IMAMURA: *Mokuzai Gakkaishi,* **38**, 233–240 (1992) (in Japanese with English summary).

A new method to improve the liquid penetration of wood using a precompression treatment was designed, and the effects of compressive deformation and its recovery upon liquid uptake were evaluated. Compression deformation was applied perpendicularly to the grain to water-saturated wood under at temperatures of 30°C and 80°C, and two types of pretreated wood were prepared; one was set-recovered wood in which deformation was released immediately after a precompression treatment, and the other was preset-fixed wood which was dried under restraint of the deformation. Set-recovered wood demonstrated two to three times the amount of liquid uptake observed in untreated wood. When preset-fixed wood was dipped in the liquid and its deformation was released, the penetration increased remarkably showing more than twenty-five times the value of the untreated softwood heartwood. No significant reduction of strength was observed for treated wood except for the specimens with pre-set as much as 60% of the compression ratio. Fractures of the pit membrane causing little damage in the unpitted cell-walls and deformation-recovery under stress-release were assumed to effectively work well to improve the liquid penetration with negligible compression defects.

Liquid penetration of precompressed wood. II. Effects of thickness and length of specimen on liquid uptake, I. IIDA, Y. IMAMURA, N. KASHIWA and Y. NAKAMURA: *J. Wood Preservation (Mokuzai Hozon),* **18**, 31–37(1992) (in Japanese with English summary).

A new method was designed to improve the precompression treatment, and the effects

of compressive deformation and its recovery on uptake of liquid solution were evaluated with respects to the deformation levels and the dimensions of specimen-size. The employment of the precompression treatment under the moisture and heat conditions effectively enabled the increase of liquid penetration of refractory wood species of the practical size.

Results obtained were as follows:

1) Liquid penetration increased with the increase of the precompressive ratio for the Karamatsu (*Larix leptolepsis* Goldon) heartwood, and the amount of liquid uptake for the precompressed wood (42% of compression ratio) demonstrated nine times as much as value of uncompressed wood.

2) The treated wood with 40–50% of precompression ratio showed the peculiar character of increasing liquid uptake with the increase of specimen thickness when the amount was expressed in value relative to volume or surface area.

3) The liquid penetration of the precompressed wood specimen decreased with the increase of specimen length in the case of the free penetration. However, the value was hold constant at the high level when pressure impregnation method was conducted. It was expected that even the long wood specimens were effectively penetrated with liquid solution when the precompression treatment was employed followed with the pressure impregnation.

Wood and termite, Y. IMAMURA: *Green Power,* No. **162**, 34–35 (1992) (in Japanese).

Feeding behavior and digestive system of termites was explained and new technique to nondestructively detect termite activity using AE (acoustic emission) monitoring was briefly described.

The exterior wood—Preservative treatment and regulation, Y. IMAMURA: *Wood Industry (Mokuzai Kogyo),* **46**, 586–590 (1991) (in Japanese).

The regulation of wood preservation was outlined with emphasis on the treatment levels of preservatives classified by end uses. The present situation of the preservative and treatment process were briefly described as well as their future prospects.

"Dictionary of abbreviations on wood science", Y. IMAMURA *et al.*: Ed. by Division Comittee of Wood-Based Materials, Japanese Society of Materials Science, Kaiseisha, p. 360 (1992).

The English abbreviations of technical terms on wood science were compiled.

Wood preservation (Mokuzai no hozon), M. TAKAHASHI: "Elemental wood science" (Mokuzai no Kisokagaku), p. 65–111, ed. Kansai Branch, Wood Technological Association of Japan, Kaisei-sha, Otsu, Shiga, p. 156 (1992) (in Japanese).

Elements of wood-preserving science, such as chractristics of wood-deteriorating organisms and toxic and non-toxic treatments to control the biodetrioration of wood, were described.

Scientific and cultural exchange among IRG members who are involved in termite research, K. Tsunoda: *Termite (Shiroari)*, No. **86**, 33–40 (1991) (in Japanese).

A few international collaborative research groups have been organized through IRG activites. The paper intrduces one of the joint investigations concerning to the relationship between termites and wood-decaying fungi and field stake trials for evaluation of wood preservatives at various parts of the world.

Recent efforts to standardize methodlogy for examination of termititcides are also outlined together with the summarized results of IRG questionnares on termites damage and termiticides.

Trends in research on wood preservation, K. Tsunoda: *Wood Preservation (Wood Preservation)*, **18**, 62–71 (1992) (in Japanese).

Recent research trends in wood preservation were outlined by reviewing IRG documents and other relevant papers with special emphasis on the development of new wood preservatives. AAC, ACQ, borates isothiazolone, chlorothalonil, and metallic naphthenates were briefly discussed on their potential as wood preservatives in the future.

Reappraisal of some fungicides by the amended JWPA test method, K. Tsunoda: The Int. Res. Group on Wood Preserv., Document No. IRG/WP/3689 (1992).

Organoiodine compounds which have been commecialized these years in Japan poorly performed as fungicides in the amended JWPA decay test (Standard 1, 1989) when applied to superficial treatment of timber. Because some parts of active ingredients seemed to disappear from the treated timber surface mainly due to the severe leaching cycles. This was prominently true for beech (*Fagus crenata* Blume) sapwood against a white-rot fungus, *Coriolus versicolor* (L. ex Fr.) Quél.

At the highest test concentration of 3% only copper naphthenate could meet the efficacy requirement (<3% mean weight loss) prescribed in JWPA Standard 7 (1989).

Pathogenicity of an entomogenous fungus, *Conidiobolus coronatus* Tyrrell and MacLeod, to *Coptotermes formosanus* Shiraki, T. Yoshimura, K. Tsunoda, M. Takahashi and Y. Katsuda: *Jpn. J. Environ. Entomol. Zool.*, **4**, 11–16 (1992).

An entomogenous fungus, *Conidiobolus coronatus* Tyrrell and MacLeod, was tested for its pathogenicity to a termite, *Coptotermes formosanus* Shiraki in some laboratory tests. Exposure of the termite workers to the fungus in inverted agar medium for 3 hr caused 100% mortality of workers within 9 days, although only two or three conidia were attached to the surface of each termite body after fungal exposure. All the workers died within only one day after fungal exposure for 6 or 24 hr. The results well demonstrated that *C. coronatus* had a very high potential to kill the termites in a short time. In contagiousness tests where a dead, *C. coronatus*-infected worker was placed among 20 or 50 sound workers, their mortality reached

100% within 4 or 5 days, respectively. The use of pathogenic and contagious *C. coronatus* in eradicating xylophagous subterranean termites such as *C. formosanus* is worth considering.

Fungal detoxification of organoiodine wood preservatives. Part 1. Decomposition of the chemicals in shake cultures of wood-decaying fungi, D.-H. LEE, M. TAKAHASHI and K. TSUNODA: *Holzforshung,* **46**(1), 81–86 (1992).

Fungal decomposition of the chemicals in shake cultures was detemined using three decay fungi (*Tyromyces palustris, Serpula lacrymans,* and *Coriolus versicolor*) and four organoiodine fungicides [4-chlorophenyl 1-3-iodopropargyl formal (IF-1000), 3-iodo-2-propynyl butyl carbamate (IPBC), 3-bromo-2,3-diiodo-2-propenylethyl carbonate (EBIP), and 2,3,3-triioballyl alcohl (TIAA)].

IPBC and TIAA were equally resistant to decomposition by *T. palustris,* and the fungal growth was inhibited at concentrations greater than 30 ppm. Decomposition rate of IF-1000 and TIAA went up to more 80% even at the highest test concentration.

Among the test chemicals only IPBC could remain intact at concentrations of 30 ppm or above, although the degrading ability of *S. lacrymans* was relatively lower than *T. palustris.*

C. versicolor showed the degrading ability stronger than the two test brown-rot fungi. Most of the chemicals were decomposed at conccntrations, below 50 ppm. IF-1000 and TIAA resisted to the active degradation at 100 ppm, although over 30% of the chemicals was lost within 20 days.

Isolation and identification of the trail pheromone of the subterranean termite *Reticulitermes speratus* (Kolbe) (Isoptera: Rhinotermitidae), M. TOKORO, M. TAKAHASHI, K. TSUNODA, R. YAMAOKA and K. HAYASHIYA: *Wood Research,* No. **78**, 1–14 (1991).

Approximately 100,000 workers of the termite, *Reticulitermes speratus* (Kolbe) were extracted with *n*-hexane to isolate trail pheromone. The extract was purified by silica gel column chromatography, normal phase HPLC and gas chromatography. Its trail-following activity was coincidentally examined by bioassays. The complete chemical structure of the pheromone was determined as (*Z,Z,E*)-3,6,8-dodecatrien-1-ol (DTE-OH) by means of instumental analyses in conjunction with several micro-chemical reactions. Sternal gland extracts also contained DTE-OH, when analyzed by capillary gas chromatography mass spectrometry high resolution selected ion monitoring (GC-MS-HR-SIM).

Identifcation of the trail pheromone precursors from subterranean termite, *Coptotermes formosanus* Shiraki (Isoptera: Rhinotermitidae), M. TOKORO, M. TAKAHASHI and R. YAMAOKA: *J. Chemical Ecology,* **18**, 517–526 (1992).

Whole-body extracts of the termite, *Coptotermes formosanus* Shiraki served for examining

the presence of trail pheromone precursor(s). Three trail pheromone precursor candidates, identifed as dodecatrienyl stearate, dodecatrienyl oleate, and dodecatrienyl linoleate, were isolated using various chromatographic methods in conjunction with bioassay and by capillary GC-MS analyses.

Presence of the trail-pheromone precursor candidates in the termite, *Coptotermes formosanus* Shiraki (Isoptera: Rhinotermitidae), M. TOKORO, M. TAKAHASHI and R. YAMAOKA: *Mokuzai Gakkaishi,* **38**, 593–599 (1992).

Whole body *n*-hexane extracts from 300,000 worker termites of *C. formosanus* were fractionated by silica-gel column chromatography. Trail-following activities were measured before and after the hydrolyses of the fractions with KOH/MeOH. Bioassay showed that the activities of hydrolyzed products were appoximately 20 times more than those of original hexane extracts. Chemical analyses revealed that the complete structures of the hydrolyzed products was coincided with that of the native pheromone,(*Z,Z,E*)-3,6,8-dodecatrien-1-ol. As the trail pheromone was collected by alkaline hydrolyses of these different fractions, it was probable that the precursor candidates were stored in *C. formosanus* termite bodies in esterified forms.

Biological resistance of phenol-resin treated wood, J.-Y. RYU, M. TAKAHASHI, Y. IMAMURA and T. SATO: *Mokuzai Gakkaishi,* **37**, 852–858 (1991).

The biological resistance of PF (phenol formaldehyde)-resin treated wood was tested in relation to the resin properties, wood species, and biological factors. When tested using water-soluble PF-resin of an average molecular weight of 170, terated wood of about 10% resin loabing *(RL)* was enough to suppress decay in Japanese cedar *(Cryptomeria japonica)* and western hemlock *(Tsuga heterophylla)* blocks exposed to *Tyromyces palustris* (brown-rot type) and *Coriolus versicolor* (white-rot type). For decay suppression in Japanese beech *(Fagus crenata)* by treating with the same PF-resin, about 20% *RL* was required for both species of fungal exposures. When using ethanol-soluble PF-resin of an average molecular weight of 300, a lesser effect on decay suppression was revealed for most of the wood-fungus combinations, suggesting a possible better penetration for lower molecular weight resin into the wood cell walls. PF-resin treatment of wood also affected termite attacks by *Coptotermes formosanus,* causing a severe depletion of feeding activity at 5–15% *RL.* Of the three species of symbiotic protozoa in the termite intestines, the most cellulolytic organism, *Pseudotrichonympha grassii* diminished first, shortly after feeding.

Biological resistance of particleboard made from phenolic resin treated particles, J.-Y. RYU, M. TAKAHASHI, Y. IMAMURA and H. KAJITA: *Mokuzai Gakkaishi,* **37**, 874–878 (1991) (in Japanese with English summary, figure and table).

Biological resistance of particleboards made from phenol-formaldehyde (PF) resin-

treated particle was investigated. For the treatment with a low-molecular weight PF-resin, we employed two methods; one was the dipping of particles in aqueous solutions of resin before spraying of the conventional PF resin as an adhesive binder, and the other was an one-step treatment of spraying a mixture of the low-molecular weight resin and the adhesive resin. Results obtained from laboratory tests showed that weight losses due to decay and termite attack decreased with increases of incorporated resin loading and board density. When the dipping treatment was employed, particleboards of 15% resin loading were protected from decay and termite attack regardless of the board density.

Biological resistance of furfuryl alcohol-treated wood, J.-Y. RYU, M. TAKAHASHI and Y. IMAMURA: The Int. Res. Group on Wood Preserv., Document No: IRG/WP/3703–92 (1992).

Biological resistance of FFA (furfuryl alcohol)-treated wood was investigated in relation to the rise of ASE (anti-swelling efficiency) resulting from the treatment. Sapwood blocks of Japanese red pine, cedar and beech were vacuum-impregnated with various concentrations of aqueous FFA solutions to get the target levels of % RL (resin loding). Air-dried blocks were kept in an oven at 120°C for 8 hours to insure the resin formation, submerged in water for 1 week to leach away the unpolymerized portion, re-dried, and exposed to decay fungi and termites. The treatment was more effective for pine and cedar than for beech to enhance their decay resistance. As in cases of chemical modification, the treatment was more effective against white-rot fungus *Coriolus versicolor* than brown rot *Tyromyces palustris*. The required RL to reduce th decay by *C. versicolor* to less than 3% weight loss was ca. 20% for both softwoods, but it was ca. 30% for *T. palustris*. FFA-treated woods were less attacked by a destructive subterranean termites *Coptotermes formosanus* and caused their higher mortarity with the increase of RL. The pretreatment of boric acid impregnation yielded the higher ASE and biological resistance at the lower RL than those of sole FFA-treatment.

Biological resistance and some properties in cell wall structure of phenolic-resin treated wood, S. MORISHITA, J.-Y. RYU, Y. IMAMURA and M. TAKAHASHI: *Woood Preservation (Mokuzai Hozon),* **18**, 201–207 (1992) (in Japanese with English summary, figure and table).

Biological resistance and some properties of phenolic resin treated wood were investigated. Full-sized wood of western hemlock *(Tsuga heterophylla)* was impregnated with a low molecular weight phenolic resin (Mw: 170) and heat-cured. Decay was virtually prevented at 14% loading in 12 week laboratory test using *Tyromyces palustris* and *Coriolus versicolor*. Treated stakes with 16% resin loading were free from termite attack for two and a half years of field exposure. Fiber saturation popint, equiribrium moisture content, and pore ratio of wood were reduced by the phenolic resin treatment. From these results, the virtual elimination of fungal and termite attack by the treatment can be explained on the

basis that the hydrophylic and accessible hydroxyl groups are blocked and that some possible barrier is formed within the cell wall by the deposit of phenolic resin.

The 22nd Annual Conference of the International Research Group on Wood Preservation, M. TAKAHASHI : *Japasese Scientific Monthly (Gakujutsu Geppou),* **16**, 84 (1992) (in Japanese).

Outline of the conference, 19–24 May, 1991, Kyoto, was described.

Presentations related to wood preservation and dwelling environment at the 19th Annual Meeting of The Society for Antibacterial and Antifungal Agents, Japan, M. TAKAHASHI : *Wood Preservation (Mokuzai Hozon),* **18**, 160–163 (1992) (in Japasese).

Presentions on wood preservation and dwelling environment at the conference were summarized.

Wood preservatives as they ought to be - on their social mission, M. TAKAHASHI : News of Wood Preservatives Association of Japan (Kogyokai News), No. 9, 2 (1992) (in Japanese).

Opinions titled above were described, especialy for the renovation of testing standards and approving systems.

Termite investigations at the 22nd annual conference of the IRG (International research group on wood preservation), T. YOSHIMURA : *Termite (Shiroari),* **86**, 12–19 (1991) (in Japanese).

Termite investigations presented at the 22nd annual conference of the IRG (International Research Group on Wood Preservation) were reviewed.

Outline of the third annual meeting of Japanese Society of Environmental Entomology and Zoology, T. YOSHIMURA : *Wood Preservation (Mokuzai Hozon),* **61**, 271–273 (1991) (in Japanese).

Outline of the Third annual meeting of Japanese Society of Environmental Entomology and Zoology was reviewed.

On what is called "SHIN-KENZAI (New Building Materials)", H. SASAKI : *New Housing (Shin-Juhtaku),* **47**(1), 8–9 (1992) (in Japanese).

What is called "SHINKENZAI" have been named on the material groups of wood-based building panels which were developed soon after the Second War and had a secondary processed surface such as plastic film or resin impregnated paper overlay, and direct print coating. The authur evaluates the contribution of these material groups to housing of Japan in some decades after the Second War.

Abstract

Needs and frontier on wood-based composites, H. SASAKI: *Forestry (San-Rin)*, No. 1301(10), 2–11 (1992) (in Japanese).

Social needs and technological flontier in the field of wood-based composites are discussed. The problems reviewed in the paper are: 1) Relation between global environment and wood industries, 2) Improvement of basic propertes of wood, 3) Frontier in developmental research on wood-based composites, 4) Needs in machine and system for production of wood-based composites.

Review on recent development with wood-based composites, H. SASAKI: Memorial Issue for the 35th anniversary of the Association of Fiberboard/Particieboard Industry in Japan, 19-27 (1992) (in Japanese).

The recent trend in the field of wood-based composites in Japan is reviewed and the development in the future of these materials are discussed in relation to their ecological or interigent propertes. The items discussed are as follows: 1) Comversion of basic properties of wood, 2) Tendency of reduction in element sizes of wood composites, 3) Di-polarization in wood-based panel production, that is, low-density thick boards, and high-performance thin boards, 4) Combination with non-wood materials, 5) Molding, 6) Pretreatment for drying wood, 7) Automatic production and high yield, 8) Less energy consumption processes, 9) Orientation of semi-flakes, 10) Trial for using extreme condition in board production, 11) Computer aided engineering in the production and application field of wood-based composites.

Utilization of laminated veneer lumber from Sabah plantation thinnings as beam flanges II. Adhesion of particleboard web and laminated veneer lumber flanges, Q. WANG, Y. IMAMURA and H. SASAKI: *Mokuzai Gakkaishi,* **38**(4), 364–373 (1992) (in Japanese with English summary).

The adhesion conditions between webs and flanges of composite beams bonded with isocyanate resin (IC) and phenol resorcinol resin (PRF) were investigated. The webs were made of low-density particleboards from lauan (*Shorea* spp.) semi-flakes, and the flanges were composed of LVL from kamerere (*Eucalyptus deglupta* Bl.) plantation thinnings from Sabah. Block-shear tests were conducted on the glue-bondings between the LVL (flanges) and the edge faces of the low-density particleboards (webs) with varying of glue spread cured at room temperature. Afluorescent chemical was added to adhesives to enable measurements of the average depths of penetrations of the glues at the webs in relation to the amounts of glue spread. In another test, the wood components were removed by chemical treatment, and the visualized glue-layers were observed by a scanning electron microscope to evaluate the morphological characteristics of the cured glue lines.

Utilization of laminated veneer lumber from Sabah plantation thinnings as beam flanges III. Production of composite beam and its properties, Q. WANG, H. SASAKI, P. YANG and S. KAWAI: *Mokuzai Gakkaishi,* **38**(10), 914–922 (1992) (in Japanese with English summary).

The mechanical properties of composite beams with webs composing of low-density particleboards from lauan (*Shorea* spp.) semi-flakes, and flanges of LVL from two fast growing species [*Eucalyptus deglupta* Bl. (ED) and *Albizia falcata* Back. (AF)] from Sabah Forest Plantation thinnings were investigated. Considering the failure behavior of the composite beams, the maximum stresses under loading condition were numerically analyzed with the finite element method (FEM) and compared with those calculated by the empirical formulas of the strength of materials.

Aligning torque generated in wood particles by an electrostatic field V. Torque due to dipole polarization and its effect on the orientation of wood particles, O.R. PULIDO, Y. YOSHIDA, Q. WANG, S. KAWAI and H. SASAKI: *Mokuzai Gakkaishi,* **37**, 711–718 (1991).

The aligning torque, T_d, generated by the dipole moment of the polar elements of wood particles exposed in an electrostatic field, was measured. Its relationship with the aligning torque, T_i, caused by surface charge polarization, that is the separation of free electric charges on the surface of the particle, was studied. Results of measurements using semi-strand particles suggest that when the aspect ratio of the particle is small, the effect of T_d on particle orientation is great. When the orientation time is short, such as in electrostatic mat-formers with underside electrodes, a small particle with a small moment of invariably orients its fiber axis parallel to the electrostatic lines of force because of the effect of T_d. However, large particles are difficult to orient in the fiber direction because the values of T_d are smaller than those of T_i.

The orientations of particles in mats formed by using two types of electrode set-ups were compared. Howere, the orientation time in the case of the topside electrodes used (height=30 mm) was short so that the effect of T_i was negligible. Accordingly, there was no significant difference in the averge alignment angles of particles oriented using topside and underside electrode set-ups. However, the orientation profiles of particle mats vary in the follwing manner: in a topside electrode set-up, the orientation degree of particles decreases as the distance from the charged electrodes increases *(horizontal profile)*. With underside electrodes, the orientation degree of particles is uniform in the horizontal direction, but it decreases as the distance from the bottom layer of the particle mat increases *(vertical profile)*.

Oriented mat-former with high voltage electrode system II. Properties of test plant-scale oriented boards, O.R. PULIDO, H. SASAKI, S. KAWAI and Y. YOSHIDA: *Mokuzai*

Gakkaishi, **37**, 1167–1176 (1991).

A test plant-scale electrostatic orientation system using high-voltage electrodes on the reverse side of the forming belt was set up. The plant can produse 750 mm wide, endless particlemats for the production of oriented particleboards. This report discusses the results of the tests conducted on oriented particleboards produced at this test plant.

The average alignment-angle of particles in the bottom layers of particle mats formed at the test plant was 20.8° which is more than the average alignment-angle (17.4°) of particles in laboratory-scale, hand-formed, oriented mats. One reason is that the particles obstruct each other during the mat-forming process because of their greater mass under test-plant conditions compared to laboratory-forming conditions. Another reason is the greater speed of the drop of particles during the forming process which renders the aligning torque less effective. The average alignment-angle increased to about 30° in the final mat or after the mat-overlay operation. Further improvements in the drum-type mat-overlay system are necessary. Because of the above-mentioned causes, the anisotropies in the moduli of elasticity (*MOE*) and the moduli of rupture (*MOR*) of oriented boards produced at the test plant were less than those of laboratory-scale boards from the same types of materials.

With this type of orientation system, small and light particles can be oriented better than large particles; therefore, the anisotropy of boards from smaller particles was more than that of boards made from larger particles. However, the bending strength values of boards made of larger particles were greater than those made of smaller particles. Orientation had little effect on the internal bond-strengths of particleboards, and it did not lessen the resistances of boards to thickness swelling.

Although some improvements still are necessary in the matoverlay process, the electrostatic orientation system used in this test plant is applicable to the production of thin oriented-particleboards for structural purposes using small semistrand-type particles.

Durability of chemically-treated particleboards, H. KAJITA, S. KAWAI and Y. IMAMURA: *J. Soc. Mat. Sci., Japan (Zairyou)*, **41,** 170–175 (1992).

Low molecular-weight phenolic resin as impregnating resin (IPR, $\overline{Mn}$=389) and high molecular-weight one ($\overline{Mn}$=962) were mixed and sprayed on sugi *(Cryptomeria japonica)* particles, and 10mm thick single-layer particleboards (PBs) (SG=0.7) were produced. On the other hand, seraya (*Shorea* spp.) particles were treated with acetic anhydride to attain at a 16% weight gain by replacing hydroxyl units of wood components with acetyl ones. The acetylated, non-acetylated, and mixed (50 : 50 weight ratio) particles were pressed into low-density PBs with densities of 0.4 and 0.5 g/cm^3 using polymeric-type urethane resin adhesive. The specimens of these two kinds of PBs and untreated PBs were subjected to various accelerated aging treatments: a) 6-cycle ASTMD-1037 exposure, b) 6-cycle WCAMA exposure, c) cyclic boil-dry test, d) BS 5669 test, and e) cyclic soak-dry test.

Thickness swelling (TS) and internal bond strength (IB) were measured after each step of each cycle. The TS after treatment a) was affected greatly by the addition of IPR or the acetylation treatment. After aging-exposure test a), the TS value of the PBs with only 5% IPR loading or the acetylated PBs was about a half of that of the control boards. The spring back was observed for the treated PBs with 20% IPR loading after cyclic exposure tests of a), b), c), and d). The exposure test affecting most severely TS and IB retention of PBs was test a), followed by tests b), c), and d), in order.